

Utilization of a Feedback Device during Cardiopulmonary Resuscitation

DNP Final Project

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by

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Abstract

Purpose: The purpose of this quality project was to assess utilization and appraisal of a real-time feedback device during a cardiopulmonary resuscitation event. Utilization of this device during a cardiac resuscitation event should assist in providing the standard of resuscitation per AHA guidelines, compression rate of 100-120/minute and respiratory rate of 10-12/minute. Additionally, this will strengthen the code quality improvement project already in place at an Academic Community Hospital.

Methods: Utilization of this feedback device was on a trial basis and was used for a period of 3 months during cardiopulmonary resuscitation events. This feedback device was a critical part of ongoing staff development and quality improvement initiatives as individualized feedback is an integral part of changing behavior, improving CPR quality and improving patient outcomes.

Quality Review Metrics: The metrics that were analyzed are those that the feedback device effects (compression rate and respiratory rate). Indirect measurements that may have been affected by this trial included the chest compression fraction as well as compression depth. This real time feedback was new for the providers as the current process of feedback is to managers, supervisors, and not shared regularly with providers. Deployment of this feedback device falls within the AHA tactics to improve resuscitation outcomes and ultimately improve patient outcomes.

Results: Baseline data was collected on five events in the three month period preceding the trial. During the three month trial period a total of sixty overhead code pages were received. Of the sixty events forty-one were excluded. There were nineteen cardiac events that qualified and three of these were excluded as the times on TrueCPR™ did not match code call times. This left sixteen resuscitation events that could be evaluated. Fourteen of the events were evaluated with

Code-STAT™ and TrueCPR™. Two were evaluated with TrueCPR only. This product did show consistency of chest compressions when used but there was no improvement in ventilation rates. Additionally, the compression ratio was already at target, for the facility greater than or equal to 90%, so there was minimal change noted on this metric. TrueCPR™ did provide feedback on compression depth that had not been measured prior to this project and findings did show there is room for improvement in this area. TrueCPR™ does show promise in improving compression rates and recognition of incorrect compression depth; however, gaps in ventilatory rate and compression depth continued.

Conclusion: Further use of the device and identification in gaps of team performance needs to be pursued as the device was not used to its full extent related to missed opportunities to use the device. Entire team process and performance will improve outcomes; correct use of assistive CPR aids may assist if used consistently and appropriately.

Utilization of a Feedback Device during Cardiopulmonary Resuscitation

Chapter 1: Nature of the Project

Introduction to the Problem

In 1998, The Institute of Medicine (IOM) issued the report known as “To Err is Human: Building a Safer Health System”. The focus of the report was the improvement of quality in health care. In the United States additional technology creates many enhancements, adding the potential of error (Kohn, Corrigan, & Donaldson, 2000). The report was the catalyst for healthcare quality initiatives related to reducing potential harm in healthcare delivery. One area where error can occur is in the inpatient health care system during cardiopulmonary resuscitation. This process begins when the patient is found to be in cardiac arrest and a code blue call is initiated. The arrival of the code team often involves many team members who do not interact together on a regular basis and their experiences vary, from novice to expert (Dorney, 2011). This encounter then creates a situation where the team’s ability to efficiently communicate, coordinate, and identify threats to patient safety may be effected (Fernandez et al., 2013).

Courses offered in cardiopulmonary resuscitation (CPR) teach hands on skills including effective compressions, appropriate ventilations, and teamwork. Performing CPR effectively can improve survival and decrease the risk of permanent brain damage (Hunziker, Tschan, Semmer, & Marsch, 2013). Although, there is evidence to show that even with this training the quality of CPR is often not satisfactory and the time when CPR is not performed remains high (Hunziker, et al, 2013). In order to improve this process a consensus statement was released by the American Heart Association (AHA) in 2013 focusing on CPR quality and improving outcomes both in and out of the hospital setting (Meaney et al., 2013).

Purpose of Project

Quality review of data for code metrics at a community campus of an academic medical center, University Hospital East (UHE), reveals advances in code mechanics but still shows the need for improvement in code performance. Several interventions have been employed to this date such as development of a standard code response, mock codes, code blue newsletters and maintenance of Basic Life Support (BLS) and Advanced Life Support (ACLS) (Appendix 1). Recent literature suggests the use of feedback devices during the resuscitation process may be a way to improve CPR performance (Pozner et al., 2011; "The Case for CPR feedback devices," 2013). The goal of this project was to utilize a feedback device during the resuscitation process to improve code metric outcomes. This goal fell within in the pending changes to CPR outcomes that were discussed at an AHA conference in November 2014. The next series for changes were scheduled for release in late 2015 with the BLS and ACLS updates emphasizing CPR quality with minimal change on the mechanics of resuscitation. The significance was reaffirmed at resuscitation officer training in December 2015.

In order to identify the feedback devices available, contact was made with representatives from Physio-Control and a literature search was performed for devices that provided real time code feedback. The TrueCPR™ feedback device was FDA approved to assist in improvement of code metrics. This project would add another layer to the resuscitation improvement process at University Hospital East and seemed to fit both the AHA standards as well as the institutional standards for cardiac resuscitation.

The impetus for improvement of the resuscitation process began with review of AHA guidelines and initiatives beginning in 2005. Review of survival prior to the release of the 2005 guidelines was dismal. Therefore the intent of the 2005 guidelines was to simplify the process

and create guidelines that may aid in improving outcomes (Hazinski et al., 2005). The guidelines in 2010 continued to build on the 2005 guidelines with an emphasis on development of critical components of high quality CPR (Meaney et al., 2013). Gaps were still evident in 2013 and work continued on development of achievable goals to improve CPR metrics as well as patient outcomes post-arrest (Meaney et al., 2013). The advent of the 2015 guidelines built on the metrics but movement will be from 5 year updates to continuous updates available online as work on resuscitation is continuously being investigated and examined and this format will allow for rapid transformation of this evidence (Neumar et al., 2015). Additionally, progress in the realm of resuscitation meets the phenomenon of interest for the DNP allowing for the development of a project providing focus within an area of expertise to build upon and dramatically improve skills related to quality and in this project focus will be on improvement of resuscitation skills delivered at the bedside during emergent situations (Moran, Burson, & Conrad, 2014).

Clinical Practice Problem Statement

In the adult inpatient population experiencing a cardiac arrest in a community academic medical center (**P**) how does utilization of an audiovisual feedback device (TrueCPR™) (**I**) compare to current code feedback (team member correction and reliance on skills learned in class) (**C**) on compression rate (100-120) and chest compression fraction (AHA minimum of 60% (institution goal of >90%), or improvement of current metric) (**O**) over a period of 3 months (**T**).

Evaluation/Summary of the Evidence from the Literature

Prior to incorporation of a resuscitation feedback device into the clinical setting critical appraisal of the literature was necessary to determine if use of a feedback device would generate

the desired practice change and impact on quality improvement (Fineout-Overholt, Melnyk, Stillwell, & Williamson, 2010). The initial search to develop the PICOT statement on the topic began in the CINAHL database using the terminology resuscitation. As development of the project continued the search was also moved to the PUBMED database. Terms that were used included combinations of resuscitation, cardiopulmonary resuscitation, feedback device, feedback, CPR, and quality. Search terms were examined individually and then combined as each term revealed multiple hits. In addition, many of the reference articles used in the creation of the 2015 AHA resuscitation updates were reviewed, and included in the literature search, in order to understand the background and formation of the 2015 guidelines. Focus was also on finding strong scientific evidence to support the change in clinical practice. Strong evidence assists in creating projects that can apply quality indicators to the process (Fineout-Overholt et al., 2010). Initially, the look back was focused within the past 5 years. However, articles from 2005-2011 were included if they were highly relevant or cited by guideline updates. A focus on quality improvement in the resuscitation process began to be emphasized with the 2005 AHA ACLS/BLS updates and work on quality resuscitation processes were heightened during this period of time. In an effort to remain abreast of current CPR developments e-mail notifications of potential articles of interest based on the CINAHL search were also received.

Review of the literature revealed variability among the articles on the use of feedback devices during resuscitation. Therefore, focus began on the most recent guidelines on cardiac resuscitation that were released in the December 2015 a supplemental *Circulation Journal* (Neumar et al., 2015). These guidelines built on the guidelines released by AHA in October 2010. These guidelines are integral into care management as the estimated number of treated cardiac arrests that occur in the United States Health Care System are approximately 200,000 per

year and this rate may be increasing annually (Merchant et al., 2011). These guidelines have been updated on a routine basis to assist medical personnel to provide care utilizing best practices and much of the treatment during a resuscitation event is based on scientific principles (Ramberg, Wolsk, Elkjaer, & Bulow, 2014). Another emphasis of the guidelines was CPR standardization the response process and skills that should be performed during a cardiac resuscitation.

The 2015 AHA guidelines were developed on the “Grading Recommendation Assessment, Development and Evaluation (GRADE) approach to systematic reviews and guideline development” (Morrison et al., 2015, p. S368). The GRADE system was developed for use by healthcare systems in 2000 and allows groups to develop “a common, sensible and transparent approach to grading quality of evidence and strength of recommendations. Many international organizations have provided input into the development of the approach and have started using it” (GRADE Working Group, n.d., p. 1). Incorporation of this process included assignment of members of the International Liaison Committee on Resuscitation (ILCOR) team to evaluate each portion of the guidelines. An electronic tool was used to develop and review their assigned section using the GRADE tool. The process involved 5 steps: PICO question development, search strategy, evidence reviewer article selection, GRADE evidence review and development of CoSTR (the draft of the consensus on science and treatment recommendations (Morrison et al., 2015). This allowed team members to assign a class (strength) of recommendation as well as a level (quality) of the evidence. This process was used to evaluate the use of chest compression feedback devices in the clinical setting. Through this process the recommendation on the use of these compression devices for “. . . real-time optimization of CPR performance [was] (Class IIb, LOE B-R)” (Kleinman et al., 2015, p. S423). In relation to the

GRADE system on the strength of recommendation, this meant that utilization of the real-time feedback devices may or may not be reasonable and may or may not be considered and the usefulness/effectiveness is unknown/unclear/uncertain or not well established. The quality of evidence is supported by evidence from 1 or more randomized control studies (RCT's) with meta-analyses of moderate-quality RCT's (Morrison et al., 2015).

While the 2015 strength of recommendation suggest little evidence for the use of the feedback device; observation of local CPR performance in clinical practice strongly supported the need to improve the resuscitation process. Need for improvement was also noted when quality data was reviewed at both the system and the UHE Code Blue Committees. Based on AHA guidelines, the key targets for improvement were ventilatory rate (the average rate per minute that are performed during uninterrupted periods of CPR), the compression rate (the actual rate/speed of chest compressions), and the CPR ratio (or chest compression fraction, the percentage of time that CPR was delivered as a percent of the total time that CPR was indicated). Local data demonstrated a need for change in two of the three areas. In regards to CPR ratio UHE is a 90% for the last quarter, the system expectation is 90%, so this meets the indicator in this area. The compression rate and ventilatory rate did show need for improvement (30% and 40%, respectively), figure 1. The system goal is to have the compression rate 100-120 at all times and the ventilatory rate 10-12 at all times (100%).

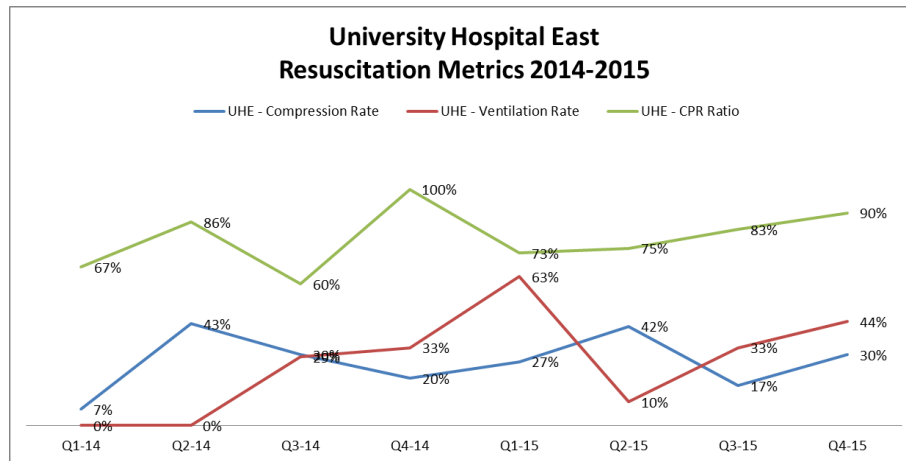


Figure 1. UHE Resuscitation Metrics 2014-2015

Combining the observed practices with the AHA guidelines created further inquiry into the quality data to see if there was a need to pursue a project to evaluate the effectiveness of these devices in the clinical setting. With the evidence from AHA and the retrospective quality data showing a need to improve code mechanics continued evaluation and synthesis of articles on the use of real-time feedback devices during the resuscitation process was completed (Appendices A & B). The literature review also supported that the use of a real-time feedback device may be of benefit but there may be some reservations in using. Additionally, use of the device is inexpensive, easy to deploy and provides minimal risk to the patient.

As mentioned previously, the 2005 AHA guidelines began the impetus for reviewing quality metrics in the resuscitation process so review of one of the early articles, Yeung et al., 2009, was important in examining the trend/use of these feedback devices. Yeung et al., 2009, completed a systematic review of the literature examining the use of CPR/prompt devices during training. They examined multiple devices that provided feedback during the resuscitation process and found good evidence to support using these devices in the clinical setting. The limitation of this review was it evaluated multiple devices creating variation in the setting,

classroom/lab versus human. Also, none of the devices tested took into account the stiffness of the bed while compressions were being performed (Yeung et al., 2009).

Bohn, et al., 2010, during a well-controlled trial without randomization found that the addition of voice prompts, using a feedback device, did not modify CPR quality or outcome. All emergency medical providers in this project received the same training prior to the intervention phase in the pre-hospital setting. Once the trial was initiated staff may have been in both groups due to the rotation of services, thus creating a cross-over effect and this may have affected results (Bohn et al., 2011).

In 2011, more literature began to appear on feedback devices. Pozner et al. (2011) completed a nonblinded randomized control trial comparing the quality of compressions and the fatigue of providers using a feedback device. The results of their small clinical trial did show improvement in chest compression quality with use of the device and there was no perceived difference in fatigue between using the device and not using the device (Pozner et al., 2011). Banville et al. (2011) completed a single well controlled trial without randomization using the TrueCPR™ device, comparing it to another device. They found the TrueCPR™ device to significantly improve and guide participants to the correct depth of compressions (Banville et al., 2011). Conversely, the metronome rate of the device was altered after this project as participants did not meet the minimum standard rate of compressions (100/minute). Both studies supported the use of a feedback device but both were small. The project by Banville appears to have been supported by PhysioControl, the manufacturer of TrueCPR™, so there may be bias in the results. Martin, et al. (2013) also completed a randomized control trial on infant manikins to review if real time feedback would improve cardiopulmonary resuscitation in infants. Their findings did demonstrate statistical improvement in quality measures related to chest compressions and does

assist with the implication that use of a feedback device might improve clinical outcomes (Martin et al., 2013).

There continued to be mixed evidence that feedback devices improved outcomes provoking more work to provide evidence on the use of the device. In 2014 another systematic review with meta-analysis of compression devices was completed by Kirkbright, et al. which did show improved chest compressions, however, they did not find that these would translate into improved patient outcomes. The difficulty they found with this review was the variability of comparing projects that used different devices and which created varying statistical significance (Kirkbright et al., 2014). Yeung, et al. completed a randomized control trial in 2014 comparing 3 feedback devices and through this work found variability among the three feedback devices studied in their ability to improve performance. They felt that an ideal feedback device does not exist (Yeung, Davies, Go, & Perkins, 2014). Zapletel, et al, 2014 compared three CPR feedback devices and found that there were differences between the devices but compressions were suboptimal in all groups and the feedback devices created a delay in CPR that may worsen outcomes (Zapletel et al., 2014).

The majority of the work published in 2015 continued to be done on manikins versus patients so there may be limitations translating this work from manikins to the adult patient population (Wutzler et al., 2015; Hsieh et al., 2015; Couper et al., 2015; Cheng et al., 2015). Two studies reviewed from 2015, Truszewski, et al. and Kurowski, et al, looked specifically at comparison of the TrueCPR™ device with other devices and manual CPR. On review of the articles many of the authors were in both studies but the subjects that were used in both studies were varied; Truszewski et al., used nurses who had no experience with feedback devices and Kurowski, et al. used paramedics. Both studies were completed on manikins and both found

compressions delivered utilizing the TrueCPR™ device to be most effective (Truszewski et al., 2015 & Kurowski, Szarpak, Bogdanski, Zasko, & Czyzewski, 2015).

The majority of authors found that the use of a real time code feedback device does assist in meeting the standards of practice identified by AHA. There is only one article, Zapletal et al, 2014, that felt use of a feedback device might worsen outcomes. Many of the reviews did show improvement in chest compressions but this did not translate to improved overall code quality and return to spontaneous circulation (ROSC). There are multiple feedback devices available for use with different mechanisms to measure chest compression depth so comparison of each device is difficult. Moreover, the quality of evidence of the research in the majority of articles is strong. Many authors were able to develop randomized controlled trials, creating a relatively high quality initiative. The drawback of these studies was they were often small and performed on manikins not human subjects at times with a crossover effect, thus limiting generalizability of information in the clinical setting. It becomes apparent that the strength of recommendation for feedback devices is weak, yet there are enough positive outcomes to justify the use in the clinical setting. In regards to use of TrueCPR™ positive outcomes were achieved related to chest compression rate and depth, with similar limitations of the project listed above (Banville et al., 2011; Wutzler et al., 2015; Truszewski et al., 2015; & Kurowski et al., 2015).

Overall, the literature suggests that there are limitation in using a real-time feedback device during the resuscitation process but those do not outweigh the potential benefits of using the real-time feedback device. After review of the GRADE guideline and the adaptation of this process by AHA and the above literature review there may be limitations in using a real-time feedback device during the resuscitation process but those do not outweigh the potential benefits of using the real-time feedback device. Furthermore, there is strength in the quality of the

evidence so with minimal risk to the patients and benefit in improved chest compressions, there is merit in trialing the use of a real-time feedback device in the clinical setting, especially as there is room for quality improvement in chest compression rate, ventilation rate, and chest compression fraction at this Academic Community Hospital.

Chapter 2: Theoretical Basis

The focus of this project involves improvement in the resuscitation process at the bedside. Before instituting this change, investigation preceded this project to see if there was alignment with the institution's goals and practices prior to implementing as the project must fit within the institutional strategic plan. University Hospital East is the Community Campus of The Wexner Medical Center, which is part of The Ohio State University. The Medical Center utilizes evidence based practice within their health care system to improve patient outcomes. The strategic plan for The Ohio State University involves a "unified single goal: Rising from Excellence to Eminence"

(http://medicalcenter.osu.edu/pdfs/about_osumc/strategic_plan_overview.pdf). This goal serves as the driving force for the University including The Wexner Medical Center. The Wexner Medical Center is further subdivided into three divisions: the College of Medicine & Office of Health Sciences, Faculty Group Practice, and The OSU Health System and Hospitals (Who is Who at OSUWMC, 2014) (Appendix C). This multitude of layers can create challenges in implementation of projects that are patient focused as there are many groups to go through for approval.

As an affiliate of the University it is imperative that the Medical Center develop a strategic plan that is in alignment with the University's unified single goal in order to maintain sustainability in the ever changing health care arena (Ginter, Duncan, & Swayne, 2013). The Medical Center's strategic goals include: becoming a top-20 academic medical center, a top-10 National Cancer Institute-funded cancer program, and generation of an investment fund for mission development

(http://medicalcenter.osu.edu/pdfs/about_osumc/strategic_plan_overview.pdf). The Medical

Center's mission statement builds on the University's goal as well as the Medical Center's goals and reads: "improving people's lives through innovation in research, education and patient care" (http://medicalcenter.osu.edu/pdfs/about_osumc/strategic_plan_overview.pdf). (Appendix D). In order to achieve this alignment with the strategic plan The Wexner Medical Center has developed tactics known as the Key Result Areas (KRA's) which "are used to set standards for performance excellence, and every area within the Medical Center maintains a scorecard to help measure institution wide progress." (http://medicalcenter.osu.edu/pdfs/about_osumc/strategic_plan_overview.pdf)gf. The key result areas include: innovation and strategic growth, service and reputation, quality, productivity and efficiency, financial performance and work place of choice (Appendix E). Institution of a quality plan for code blue response The Wexner Medical Center seems to be a natural match in attainment of the institutional goal of moving from excellence to eminence as there is focus on quality and several of the key result areas are affected that may assist in movement of the institution from excellence to eminence. This project can be perceived as innovative as there are studies to support the use of the feedback device but not all institutions have the infrastructure to support this type of change.

Within the Medical Center structure quality initiatives for code blue are created by the system code blue committee. This committee is charged with development of best code blue practice and monitoring of code blue and early recognition processes and teams. Codes are further reviewed at University Hospital East within the code blue committee. One metric that has been measured for several years is alignment with AHA standards on performing high quality CPR, with a rate of 100-120 compressions per minute, minimizing pauses during the code (<10 sec) and ventilation rates (10-12/minute). Improving the quality of CPR will be

imperative as CPR is the foundation of resuscitation and the key to improving outcomes (Meaney et al., 2013). Therefore, work needs to continue on improving the quality of CPR as “poor-quality CPR should be considered a preventable harm” (Meaney et al., 2013, p. 2). The four areas that are stressed for improvement in the consensus statement are: “metrics of CPR performance by the provider team; monitoring and feedback: options and techniques for monitoring patient response to resuscitation, as well as team performance; team-level logistics: how to ensure high-quality CPR in complex settings; and CQI for CPR” (Meaney et al., 2013, p. 2).

These national goals have been set and adopted by the code blue committee as the survival rate post cardiac arrest for the adult patient is 18% (Meaney. et al., 2013). This low percentage of survival has been identified by the AHA as an area for improvement. The Emergency Cardiovascular Care (ECC) a division of the AHA has recently developed three goals pertaining to outcomes of cardiac arrest to be achieved by 2020 (Bobrow, Meaney, & Berg, 2014). The inpatient goal for the adult patient population is to double the survival rate from 19% to 38% (Bobrow et al., 2014). The 2015 guidelines also built on the consensus statement examining CPR quality with the intent to improve outcomes post cardiac arrest as the current guidelines have focused on high quality CPR and outcome data showed there is a disparity between the 2010 guidelines and the outcomes (Bobrow et al., 2014 & Meaney et al., 2013).

The current process improvement strategy that the Medical Center utilizes is the DMAIC methodology. The DMAIC is a process improvement initiative affiliated with Six Sigma that assists with placing structure to process improvement (Carey, 2016). The foundation of instituting the real-time feedback device during resuscitation is process improvement; however, it also involves the application of evidence based practice (EBP) as the foundation for change so

the Rosswurm & Larrabee model for change to EBP was employed for this project. This model takes into account that “EBP is more likely to occur in practice settings that value the use of new knowledge and provide resources to access that knowledge” (Rosswurm & Larrabee, 1999, p. 317). Furthermore, the model is useful in primary and acute care settings and this project will occur in an acute care setting and will involve utilization of bedside staff to create the change. This project will create a change from the current practice. Currently data is obtained from codes through the defibrillator that is used during the code. However, staff are often not aware of the information until the end of the quarter so deployment of the feedback device will provide real-time feedback to the team during and immediately after the code allowing them to become an active part of the process. This can potentially benefit CPR quality in several ways, improving the code mechanics but also increase their satisfaction with patient care delivery during resuscitation and assist with improvement in the key result area of work place of choice.

Rosswurm and Larrabee’s model involves six steps: Assess the need for change in practice; link the problem, interventions, and outcomes; synthesize best evidence; design practice change; implement and evaluate change in practice; and integrate and maintain the change in practice (Rosswurm & Larrabee, 1999).

As mentioned above the need for change for this project involved trying to take the data that is currently generated during codes to the bedside. The current process involves gathering data from the defibrillator after a code and generating this information into a report that is viewed, by committee members, not always the bedside staff, on a quarterly basis. Rosswurm and Larrabee’s model has the bedside staff as integral to creating the change and this is also the premise behind the real-time feedback device (Rosswurm & Larrabee, 1999). Use of the real-time feedback device allows code team members to see what the compression rates are, if

following the device. They are also instructed when to deliver respirations, while the patient is not intubated, which would keep the rate slower and more effective. The device also signals when compressions have not been performed after 10 seconds, the maximum time that compressions should be ceased. This device will also link them to current best practice as the feedback device is programmed to assist in delivering compressions and ventilations at the rate recommended by AHA to obtain ROSC. Literature has been synthesized to show there is evidence to support this change. Although the evidence is not strong at this time it is supported by higher level research studies. Research did support that change occurred after education on the TrueCPR™ device (Kurowski et al., 2015 & Truszcwski et al., 2015). Support for the device was received from the staff, clinical nurse specialist, nurse manager, University Hospital East code blue physician and the system code blue committee. Data will be reviewed periodically throughout the project and at the conclusion of the project. Integration and maintenance of the feedback device will be dependent of findings, use of device and feedback from staff members at the conclusion of the trial period. (Appendix F).

Chapter 3: Recommendation for Change

Project Design

An evidence based project was designed to examine the effect on compression rate, chest compression fraction, and respiratory rate with utilization of a feedback device during the code resuscitation process. These variables were compared prior to the implementation, baseline period, and during the enactment of the real time feedback device. This project was conducted using Physio-Control's TrueCPR™ feedback device. This device was chosen because the device is compatible with other instruments used during CPR that are manufactured by Physio-Control at the Wexner Medical Center and with CODE-STAT 9™ which provides data on the rate of compression and ventilation during the code, after the code has occurred. The feedback by TrueCPR™ will provide staff with immediate feedback on the compressions and ventilations during the code so coupling these devices from the same manufacturer will provide the opportunity for comparison of data prior to use of TrueCPR™ and with use of TrueCPR™. Contact was made with the manufacturer of the device and they are interested in pursuing this trial at UHE.

TrueCPR™ received FDA approval on April 17, 2013. The intended use of the device is “to provide feedback to assist rescuers to perform cardiopulmonary resuscitation (CPR). Rescuers must be trained in CPR and use of the device. The TrueCPR device is intended for use on patients eight years of age and older” ("TrueCPR(TM) FDA approval," 2013, p. E-2). All code providers at UHE hold CPR training cards and were trained on the device prior to the trial. Also, staff were instructed on age limitations of the device. UHE is an adult inpatient facility and pediatric patients are only admitted with permission of the medical director so there is minimal risk of using the device outside the intended recommendations for the product.

The Wexner Medical center purchasing department and product committee were also contacted and were agreeable to the trial and assisted with the purchasing process. Pursuant to a request by the purchasing department, prior to the trial, a zero dollar purchase order was created to obtain the devices during the trial. The purchasing department also assisted with development of analysis and evaluation forms for this project. This cost analysis listed the cost of the device at \$1651.40. This is not a capital purchase so this can be purchased through the traditional purchasing order process. The only additional cost would be for batteries, the cost of the batteries is \$17.40 for a box of 6. The analysis revealed there is no current product in the system that could be used to provide the same information. The product is relatively inexpensive but it was still important to examine TrueCPR™ during a project period to establish if the proposed outcomes are as stated and there is benefit to the patient and code team utilizing this device. Completion of this evaluation will allow for the initiation of a quality trial, Appendix G.

Approval for the project was also obtained from the system code blue committee as well as the University Hospital East Code blue committee and the physician lead of this committee. As mentioned earlier this project is a continuation of quality improvement initiatives that are already in place.

Originally, an *Institutional Review Board* (IRB) submission was written and submitted. Soon after this was submitted a *Human Subjects Research Assessment Form* was created and implemented by The Ohio State University College of Nursing. This process determines a project's status as a quality project or research project requiring IRB approval. This project was determined to be an evidenced-based quality improvement project and the IRB submission was retracted. Approval was also obtained from The Wexner Medical Center after submission of the data quality release form. The project also underwent review and approval from The Ohio State

Wexner Medical Center (OSUWMC) Nursing Feasibility Review Committee. This committee reviews the project for available resources, appropriateness of the project's timeline, the extent of similarity with the Medical Center's mission and goals and any potential conflicts of interest. The only concern that was brought forward during these reviews was the inability to accurately predict the number of patients that would be resuscitated during this time period and limited interaction with the staff to remind them to use the device during the patient resuscitation events. In order to overcome the barrier of contact with the staff work was completed with the clinical nurse specialist (CNS) at University Hospital East to gain her support of this project. Education was provided one week before the project was to begin with periodic in-services and question/answer sessions during the three month time period. The CNS did not assist with data collection but did confirm if overhead codes required CPR. The process of code downloads did not change, information was collected by code blue quality team members. Additional time, of several minutes, would be required for each download as this project required a download of the defibrillator as well as the TrueCPR™ device.

The trial was conducted at University Hospital East, a Community Hospital campus of The Ohio State University, Wexner Medical Center from February 1 to April 30, 2016. The feedback device was a critical part of ongoing staff development and quality improvement initiatives as individualized feedback is an integral part of changing behavior, improving CPR quality and improving patient outcomes. During this time any patient over 18 years of age who requires cardiac resuscitation was to have this device used as a standard of care during this period of time. Three devices were obtained from Physio-Control and stored in the ICU for use. One device was kept on each crash cart in the ICU making it easily accessible for all staff members and could be used on the patients coding in the ICU. The third device was stored with

code supplies currently taken by the ICU staff to codes called on the inpatient med/surg and progressive care units. Once the ICU RN arrives at the code the device was to be turned on and then placed on the patient's sternum and under their back. This process takes seconds and should not interfere with the resuscitation process. Staff can then use the metronome and visual prompts from the device to assist in the resuscitation process.

Training occurred with code team members (ICU RN, PCU Charge RN, respiratory therapy, and hospitalist physicians). Education included how to use the device as well as reviewing performance metrics. The metrics reviewed included the expected compression rate (100-120/beats per minute), chest compression fraction (>90%), ventilation rate (10-12 breaths/minute) and chest compression depth (>5cm, 2inches). The training took no longer than 15 minutes to complete and sign in sheets were maintained of staff attending and provided to managers to validate staff education. (Appendix H)

Quality Metrics

After the code has concluded, the current quality review process is to abstract data on code performance from the defibrillator used during resuscitation, using Physio-Control's CODE-STAT 9™. The data that is generated includes: compression rate, chest compression fraction, ventilation rate. The information from the defibrillator is downloaded to a computer secured by the quality department. After the files are secured on a password protected computer they are uploaded from this computer to a secured, password protected Medical Center website. The information is then generated into documents maintained on a secure website by the quality department. The data that is reported has been de-identified and is reported on a quarterly basis at the Code Blue Committee Meeting, but there is ability to look at data over defined periods of time. The current reporting method provides information at the health system level as well as by

individual business units. For this project, UHE will be the business unit that will use the device, so pre and post data from this business unit will be presented. The metrics analyzed are those that the feedback device effects. The device, as mentioned above, will give the code team information on compression rate, depth and respiratory rate (as long as the patient is not intubated). Additional information on compression depth will be ascertained during the trial. The measurement of this information will be compared from the start of the trial to the conclusion of the trial, as this data is not able to be obtained from the defibrillator at this time. It is anticipated that providing this real time feedback during the code will assist in improving these measures and potentially the chest compression fraction ratio (the amount of time compressions are performed during the code). The actions that are being monitored fall within the AHA tactics to improve resuscitation outcomes.

Chapter 4: Findings

Overview of Results

The effect on compression rate, chest compression fraction, and respiratory rate with utilization of a feedback device during the code resuscitation process was examined as baseline data three months prior to the intervention (November 2015 – January 2016) and then for three months with the use of TrueCPR™ (February 2016 – April 2016). The baseline data was only reviewed from the existing CODE –STAT 9™ database, there was not analysis of all codes called and excluded from the CODE-STAT 9™ downloads. Data was collected in a similar manner during the project but overhead calls were also evaluated to see if any potential data collection events were missed. A true code, or evaluated code, was defined as a cardiac event in which CPR was initiated. During the baseline period 5 cardiac arrests were evaluated using the CODE-STAT 9™ process. There was more activity during the project period. There were a total of sixty code events called overhead, four were excluded as they were in response to an independent facility within UHE. There were also 37 events that were non cardiac events, such as respiratory compromise and cardioversion, which were excluded. In one case the defibrillator was not placed in a mode that allowed for capture of information so it could not be determined if this was a cardiac event so this case was also excluded. Of the remaining nineteen events three were excluded as the times did not match the information in the CODE-STAT 9™ database and they were marked as nonevents. Fourteen resuscitation events were evaluated using both CODE-STAT 9™ and TrueCPR™ and two events did not have CODE-STAT 9™ data but there was TrueCPR information. TrueCPR™ was used six times during the trial period. Figure 2, represents the breakdown of this information.

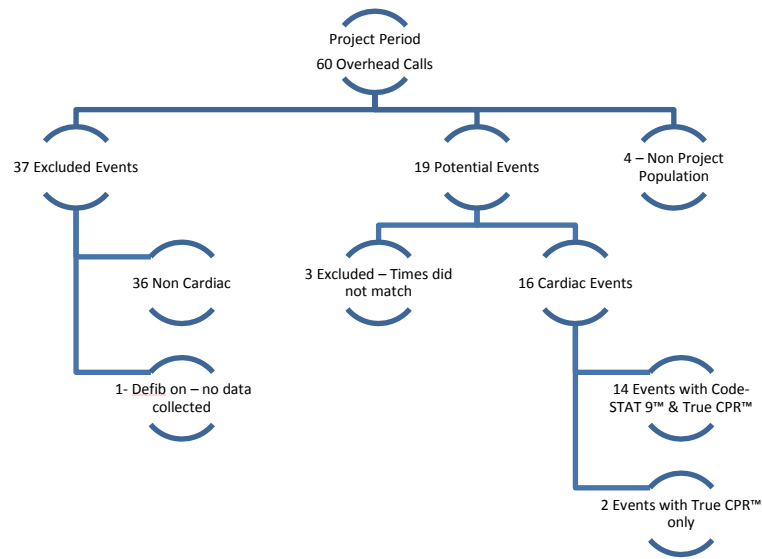


Figure 2. Breakdown of Overhead Calls during 3 month project

Figure 3 illustrates the information from the baseline and project time periods. During the baseline period there was one code where the ventilation rate was not able to be obtained as evidenced by the empty box. The median for the compression ratio is within the desired range, >90%, and was 91%. The median compression rate was 123, which is slightly above the desired range of 100-120 compressions/minute. Additionally, the compression rate had variability ranging from 101-142. The median ventilation rate was 15.5, which is also above the preferred target of 8-12.

During the project period there were fourteen events evaluated using CODE-STAT 9™. There were two additional events that were obtained by TrueCPR™ that are not represented in this figure but will be represented in the Figure 4. There were three events that ventilation data was not able to be obtained. The four highlighted events in figure 3 had TrueCPR™ providing the opportunity for real time feedback during the resuscitation process as well as CODE-STAT 9™ information. The median compression ratio was 94%, above the baseline period, the median compression rate was 114, within the 100-120 range and the median ventilation rate was 15.5,

above the expected rate of 10-12. Variability still occurred during this trial period within the compression ratio (72%-100%), compression rate (107-188) and in the ventilation rate (7-19).

Baseline Nov 2015 - Jan 2016	Compression Ratio (%)	Compression Rate	Ventilation Rate	Pilot data Feb 2016 - April 2016	Compression Ratio (%)	Compression Rate	Ventilation Rate
	92	113	16		72	134	8
	91	123	10		94	107	16
	85	130	15		95	111	15
	91	142	19		94	110	17
	92	101			90	111	13
					100	188	
					99	132	
					94	114	13
					100	117	
					100	114	7
					86	107	15
					97	112	19
					79	130	15
					93	128	15
median	91	123	15.5	Median	94	114	15
max	92	142	19	Max	100	188	19
min	85	101	10	Min	72	107	7

Figure 3. Baseline (Nov 2015 – Jan 2016) and Trial Data (Feb 2016-April 2016).
Information from Code-STAT 9™

Figure 4 represents the TrueCPR™ information only. In these six events there was still variability within the compression ratio and ventilation rate; however, the compression rate median was 108 and ranged from 100-114. The compression rates do meet the AHA standards consistently when the device was used. Examination of the data from CodeSTAT 9™ and TrueCPR™ show minimal variability within data points providing assurance that the data collected with real time feedback is valid and reliable.

True cpr	Compression Ratio	Compression Rate	Ventilation Rate
	100	100	7
	86	107	15
	97	112	19
	94	114	13
	87	105	
	92	109	
Median	93	108	14
Max	100	114	19
Min	86	100	7

Figure 4. TrueCPR™ Data

Comparison of Results

Chest Compression Ratio

As mentioned previously the chest compression ratio is the time that CPR is provided during the code, ultimately the goal is avoiding interruptions during the compression process. Ideally, there should be no greater than ten seconds off the chest while CPR is being administered. The Wexner Medical Center has established the threshold of 90% for the chest compression ratio. There were only five codes in the baseline period preceding the trial there was only one event that fell below threshold, creating 80% compliance to the expected threshold. There was also variability during the project period with 78% adherence to the chest compression ratio of 90%. Figure 5 displays the comparison of the compression ratio prior to and during the trial of TrueCPR™. The green line represents the target threshold of 90%.

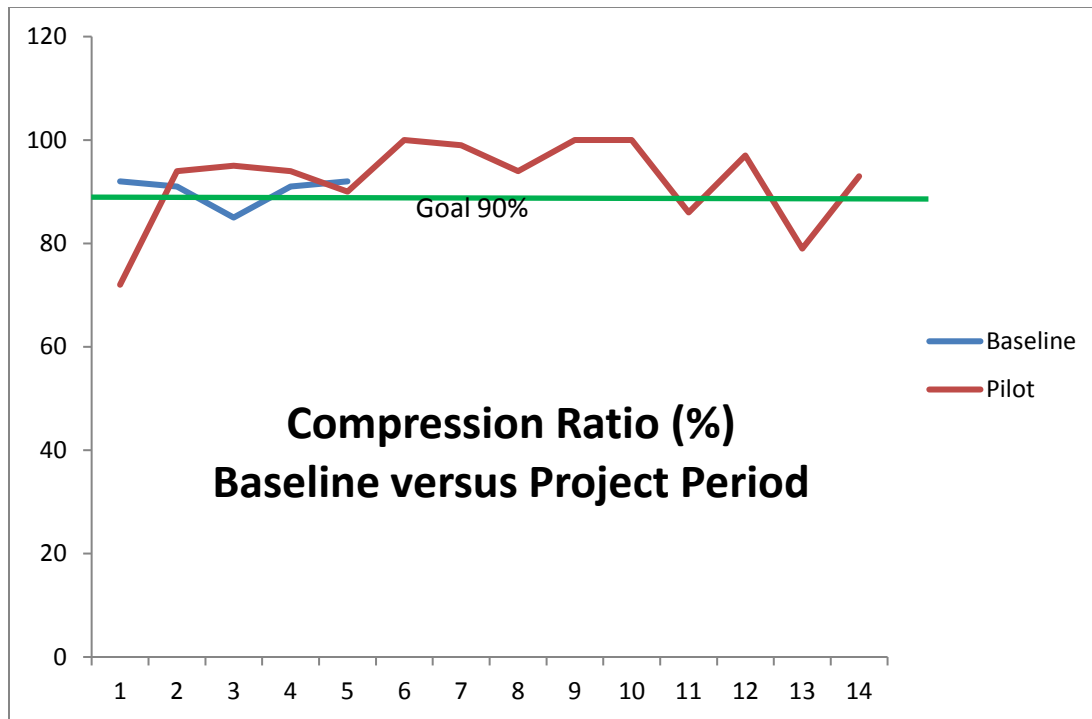


Figure 5: Comparison of chest compression ratio

Compression Rate

The recommended compression rate from AHA is 100-120 compressions/minute. Figure 6 represents the compression rate findings during the baseline and project period. Again, the green lines represent the target area for this metric. There is variability of the compression rates both prior to and during utilization of the real time feedback device. However, during the baseline period the target range was achieved only 40% of the time and during the project the target compression rate was achieved 78% of the time with only six of the fourteen events having used TrueCPR™. Figures 7 and 8 have isolated the use of TrueCPR in comparison to the baseline and the project. The utilization of TrueCPR™ did ensure that compressions were performed in the target range of 100-120 compressions/minute 100% of the time.

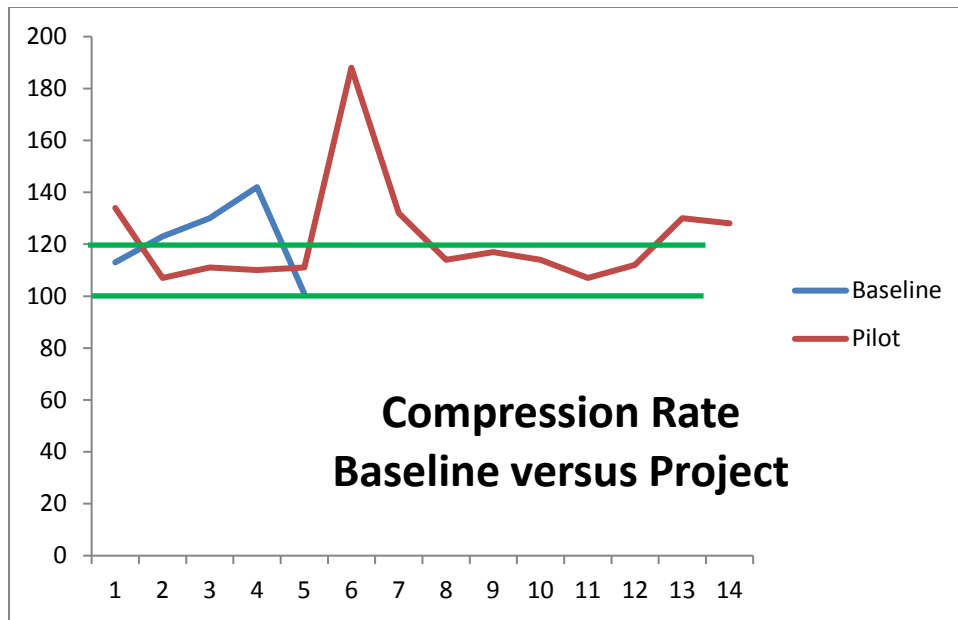


Figure 6. Compression Rate: Baseline versus Project, green lines indicate target range

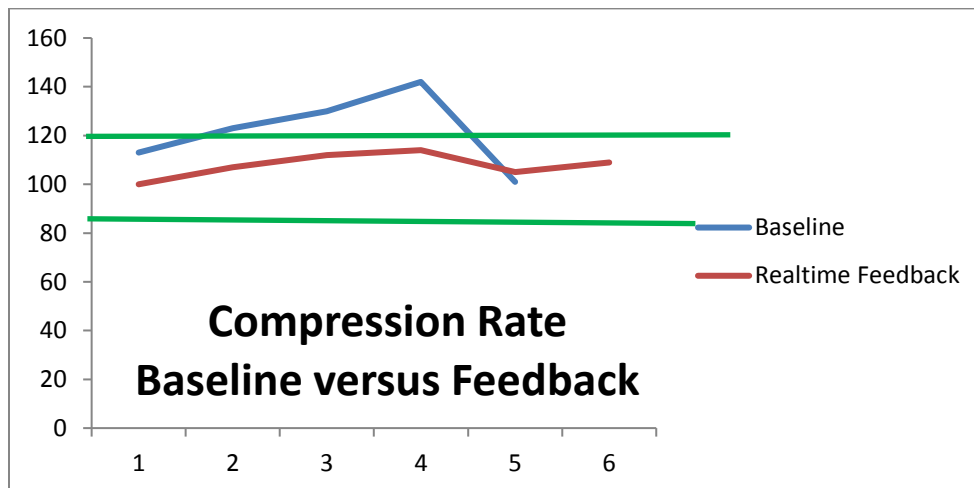


Figure 7. Compression rate: Baseline compared to use of TrueCPR™, green lines indicate target range

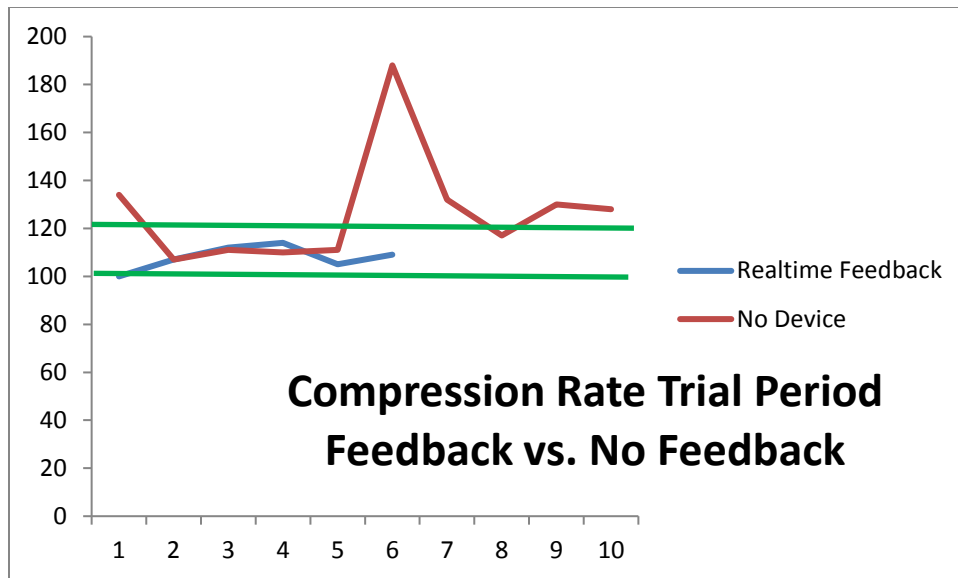


Figure 8. Compression rate: Trial period – comparison TrueCPR™ compared to no device, green lines indicate target range

Ventilation Rates

Ventilation rates do have an impact on the code response and are included in the CODE-STAT 9™ information. Moreover, TrueCPR provides ventilation cues when the patient is not intubated that could be followed to promote ventilation in the target range of 8-12 breaths/minute. The ventilation cues would most likely be used on the medical/surgical units as these patients are not intubated. During the project 28% of the codes occurred on these units so ventilations could have been impacted on this patient group. Figure 9 represents this information for both the baseline and project periods. There is variability among ventilations in both periods. Use of TrueCPR™ did not impact this metric.

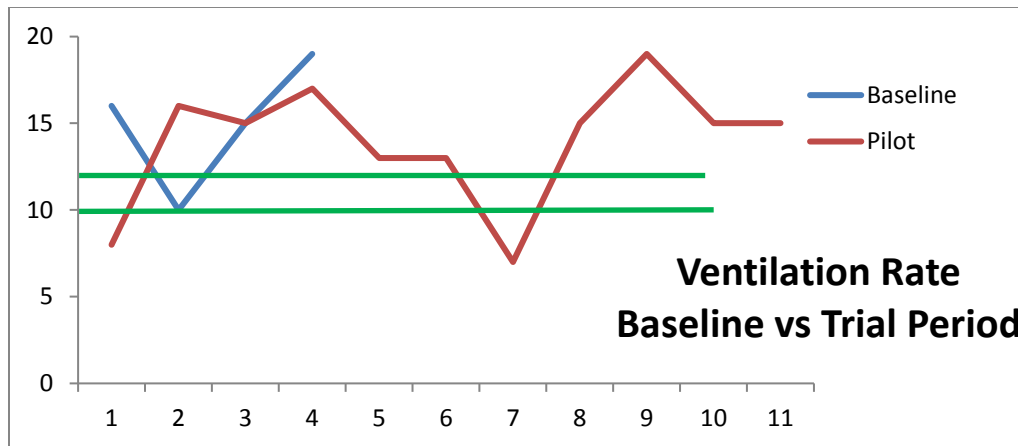


Figure 9. Ventilation rates (breaths/minute) comparison of baseline and trial periods

Additional information was obtained from TrueCPR™ that was not available from the current process of code review and includes the depth of compression, as well as a summary of the longest pause during the resuscitation event as well as the number of pauses that occur over ten seconds. More work needs to continue to minimize these long pauses and potentially improve code outcomes. The depth of compressions has not been able to be measured prior to the utilization of TrueCPR™, the ideal compression depth should be 2-2.5 inches (Kleinman et al., 2015). During this trial the 6 patients who had the TrueCPR™ placed ranged in target for correct depth of compressions from 0% to 28% (see figure 10). Further breakdown of compression depth measured the administration of 4,213 compressions in these six events. Of these compressions only 412 were within the desired range of 2-2.5 inches for a total of 10% in range. Compressions were too shallow in 3,790 (90%) of measured events and too deep 1% of the time. This new information on code metrics lends itself that further focus and education needs to be completed on compression depth.

True CPR Summary							
Compressions Duration	0:24:58	0:02:23	0:01:57	0:00:15	0:12:15	0:00:35	
Pauses Duration	01:37.3	00:26.0	00:15.7	0:00:00	01:00.2	0:00:00	
Compressions Ratio	23:20 / 24:58 = 94%	01:57 / 02:23 = 82%	01:41 / 01:57 = 87%	00:15 / 00:15 = 100%	11:14 / 12:15 = 92%	00:35 / 00:35 = 100%	
Compression Count	2514	204	174	27	1233	61	
Good Compressions	308 / 2514 = 12%	57 / 204 = 28%	1 / 174 = 1%	0 / 27 = 0%	19 / 1233 = 2%	0 / 61 = 0%	
Longest Pause	19 sec	10 sec	87 sec	25 sec	168 sec	18 sec	
Longest Interval w/o Good Compressions	144 sec	88 sec	95 sec	14 sec	496 sec	35 sec	
Pauses over 10 sec.	2	1	2	1	2	1	
Compression Depth							
Measurement Units	Inches	Inches	Inches	Inches	Inches	Inches	
Compression Depth	1.8 (1.6, 1.9)	1.7 (1.5, 2.0)	1.7 (1.6, 1.8)	0.9 (0.7, 1.0)	1.2 (1.1, 1.4)	1.0 (0.9, 1.1)	
In Target Depth Compressions	334 / 2514 = 13%	57 / 204 = 28%	1 / 174 = 1%	0 / 27 = 0%	20 / 1233 = 2%	0 / 61 = 0%	
Too Shallow	2171 / 2514 = 86%	145 / 204 = 71%	173 / 174 = 99%	27 / 27 = 100%	1213 / 1233 = 98%	61 / 61 = 100%	
Too Deep	9 / 2514 = 0%	2 / 204 = 1%	0 / 174 = 0%	0 / 27 = 0%	0 / 1233 = 0%	0 / 61 = 0%	
Compression Rate							
Compression Rate	109/minute	106/minute	105/minute	109/minute	109/minute	104/minute	
In Target Rate Compressions	2261 / 2514 = 90%	193 / 204 = 95%	169 / 174 = 97%	24 / 27 = 89%	1187 / 1233 = 96%	55 / 61 = 90%	
Too Slow	97 / 2514 = 4%	9 / 204 = 4%	3 / 174 = 2%	2 / 27 = 7%	16 / 1233 = 1%	6 / 61 = 10%	
Too Fast	156 / 2514 = 6%	2 / 204 = 1%	2 / 174 = 1%	1 / 27 = 4%	30 / 1233 = 2%	0 / 61 = 0%	

Figure 10. Summary of TrueCPR™ Patients (February 2016-April 2016)

Throughout the project duration, anecdotal feedback from the staff was variable and this product was being projected so staff feedback on the device was obtained using a template form obtained by the purchasing department. Only four evaluations were received through this process as staff appeared to be hesitant to evaluate based on education and return demonstration only. 50% requested more time with the device to evaluate and the other 50% wanted to utilize the device. Anecdotally, and in the survey results the metronome on the device was found to be very helpful during the resuscitation process. Figure 11 is a summary of the survey results.

Trial Criteria	Yes	No	Comments
Did this product perform as indicated?	4	0	
Did this product delay time to compressions?	0	4	
Were compressions stopped to place product for feedback?	2	2	
Was setup of the product cumbersome for you or the support staff?	2	2	The lady was very small and the machine kept slipping
Is there potential to assemble this product incorrectly?	1	2	
Is there potential to use this product against the manufacturer guidelines that could result in a patient safety concern? Please indicate how if yes	1	3	
Did you receive appropriate education on the feedback device?	4	0	
At the conclusion of the code did you debrief using the information on the device?	0	4	
When the device was used during a code was the metronome used without placing the device under the patient?	2	2	and loved it.
When device used during the code was compression rate and/or depth adjusted during resuscitation?	4	0	
I want this product	2		I really like the metronome feature. I think it's going to take people awhile to get used to using it, but I feel it is definitely a helpful tool
I need more time with this product	2		
I do not want this product	0		

Figure 11. Staff evaluation of TrueCPR™

Chapter 5: Discussion and Implications for Practice

Discussion:

Throughout the project duration, anecdotal feedback from staff has been variable. When in-servicing began concerns were raised on the size of the device. However, all staff seemed willing to try and all were able to return demonstrate the use of the product prior to, at the start and during implementation. In total seventy-eight staff members were in-serviced on the device. As the trial continued staff did state they forgot to use and/or bring the device to the code. Feedback from staff on several of these occurrences was the duration of the code was short and they did not have time to place the device. However, there were two resuscitation events where the device was placed and the event was less than one minute and the TrueCPR™ was also utilized in two codes of less than one minute. Also, staff was advised not to use the device during one code as the patient had a large body habitus. This is not a contraindication for the device so re-education was provided that it was appropriate to use this device on this type of patient.

Ongoing visits and education were provided throughout the trial to answer questions and provide support. The early education and ongoing contact with the staff may have created a Hawthorne Effect on the outcome measurements. The Hawthorne Effect occurs when participants are aware their behaviors are being followed and quality reviews are being completed (McCambridge, Witton, & Elbourne, 2014; Campbell, Maxey, & Watson, 1995)). Although used in only 38% of the potential cases the device may indirectly affected outcomes as staff had been re-educated on resuscitation standards while educating on device use. Staff awareness was also heightened during the trial that code metrics were being collected and monitored. Review of the device post-event occurred on two occasions and a presentation with

the outcomes was provided in person and placed on a bulletin board in the nurse's station in mid-April. The metric with the potential impact from these factors was achievement of the goal compression rate which went improved 40% during the baseline period to 78% in the project.

As this product went through the product committee written feedback and evaluation of the device were obtained, although not necessary for the initial scope of this trial. Although there were only 4 evaluations (figure 11) completed these did summarize many of the anecdotal statements received during the trial. In regards to the size of the device and providing compressions with the device a staff member reported after a code that it "was a slippery mess," as the device moved while trying to perform compressions. This feedback was provided to Physio-Control, the manufacturer of the device, with the response that they were aware of this concern and had no recommendation for changes at this time. This may have an impact in purchasing the device. There is another manufacturer that has a similar device to the TrueCPR™ but it is built into the defibrillator; however, this would require the purchase of all new defibrillators for the institution. Although none of the evaluations stated that the size of the device hindered the outcome of the code, this is a possibility. During the trial one device was not able to be used for several days as the batteries needed to be replaced. However, there were two remaining devices on the unit that could have been used while waiting for the batteries. There is a battery indicator light on the device and if incorporated into the resuscitation process this check would have to be placed on the daily crash cart checklist to assure the patency of the device.

When using the device, feedback from the staff involved felt the metronome was helpful and information was provided that on several occasions that the device was used for the metronome but not placed under the patient. The CODE-STAT 9™ data did show improved and consistent compression rates during the trial period (Figures 7 & 8). However, when reviewing

codes the reviewer cannot tell if TrueCPR™ has been used unless the device is placed under the patient and compressions have been initiated. If the device was used for the metronome there is an effect of the device; however, staff reviewing code information would not know the metronome was used if compressions were not performed. An alternative to purchasing and using this real time device may be to utilize the metronome on the defibrillator. The institution is in the process of purchasing new defibrillators which have a metronome built into them. If the defibrillator metronome is used expectations will need to be established, in-servicing provided and the initiation of the metronome into the code quality outcome timeline to see if this has an effect on code outcomes. Work on the code blue committee has shown that there is not any one variable that is creating change; there are multiple variables that come into play in creating derived outcomes so incorporation of all insight gained on the resuscitation process is imperative.

There was minimal change on the compression ratio and no change on the ventilation rates during the trial. Both these processes are performance metrics; however, they also involve critical thinking and coordination of the team members for hands on skills that are not used on a routine basis. TrueCPR™ has the ability to be used both during and right after the code to provide feedback to the code team yet the evaluations indicated that this function was not used during the code debriefing process. This real time feedback is one method that could be used to improve team performance. Many staff felt that there is not time after a code to debrief so this feedback process may need to be re-examined. If the cost of the device is prohibitive for use and CODE-STAT 9™ is already a product that is in use, generation of simple post code data may be generated and developed into a scorecard that may impact performance. Utilizing the Hawthorne Effect that was previously mentioned if staff is aware that they are being monitored their

performance may improve (Campbell et al., 1995). A sample of a posting that may be utilized can be found in appendix I.

Teamwork is vital in the code process and especially during pauses in the compressions and ventilations. Review of CODE-STAT 9™ data through this project revealed a great need for decreasing the ventilation rate. Despite the fact TrueCPR™ gives a metronome for ventilations they were not done at the correct rate. Providing feedback when the compressions are paused is also an essential component in improving code outcomes. TrueCPR™ has the ability to provide this information while in place, when compressions are paused the device begins to count up and when ten seconds are reached the numbers turn red. Both ventilations and pauses rely on mechanics of the code but they also rely on communication between the team members. The team must be comfortable relaying performance information to each other. On data review and anecdotally, not all team members are comfortable correcting one another so more work may need to be done to improve this communication among team members. This is another area in code process improvement that can be developed and may have an impact on code team performance and ultimately code outcomes.

Compression depth was a new area where data was discovered during this process. Anecdotally, it has been noted that if the patient survives that everything was done appropriately, but analysis of the codes reveals that there is still work to be done. The accuracy of compression depth was 0-28%. This information is not promising but several factors may come into play related to the depth, responder fatigue as well as compressions performed on a bed with a mattress. TrueCPR™ may assist to correct the depth; however, ongoing education on the device would be needed as it appears compressions may not have been adjusted with the real time feedback and they often did not review data in the debrief period. Again, if TrueCPR™ is not

used end tidal carbon dioxide (ETCO₂) is a measurement that can be used to measure adequate compressions (Link et al., 2015). Currently, use of ETCO₂ is to be the standard during codes at the Wexner Medical Center. However, these devices are not placed until intubation and during the project 28% of the codes were initiated on medical/surgical nursing units where patients are not intubated at the start of the code so the ETCO₂ information would not be readily available. Additionally, these values are not always verbalized and/or not documented during codes so this may be another process that can be looked at to improve resuscitation outcomes.

Limitations

The most prominent limitation was staff engagement in the process. Although Rosswurm & Larrabee's model for change was used as the basis for this project more planning could have occurred to obtain staff's participation in this project. Support at the point of care is crucial to improve code outcomes as they are the ones providing the care. Teamwork is vital in the code process and especially during pauses in the code and providing ventilations at target rates. Increased participation may have increased the use of the device as well as post code debriefing. Utilization of a champion of the device on the unit may have instilled more use of the device. The use of this device as well as improving communication among team members is crucial for noted improvement in the code process.

The other noticeable limitation was the number of actual cardiac resuscitations that occur in a given period of time. It is difficult to implement change when there is uncertainty of when the event will happen, when there are a limited number of events to respond to, and the response team can vary from event to event. Review of the previous year's data revealed there were more codes than actually occurred during the trial. This was especially true during the 3 month period

prior to the actual initiation of the device. The decrease in events may be a reflection of the processes in place in the early response period and successful implementation of measures to prevent codes. Ultimately, early recognition is tied to the resuscitation process and a successful program could lead to the reduction of cardiac events. Therefore, it is important to find ways to engage all potential team members in the process to ensure successful implementation of a change in process.

Implications for Nursing Practice and the DNP Essentials

The focus of this project has implications for the bedside practitioner as they are often the first person to respond to an emergency event. As a DNP it is imperative to include them in the development of future changes in the resuscitation process to ensure success. The science of resuscitation is at the cutting edge and it is up to the DNP to be able to integrate the evidence with the actual practice that occurs at the bedside. This project has shown that information is generated nationally and at the systems level but does not always make it to the bedside in an organized manner. The DNP must use the skills developed in both quality improvement and systems thinking to initiate a successful plan at the bedside. Although gaps were noted in this project; review of the process opened opportunities to continue to improve the resuscitation process and gain the support of the bedside clinicians.

This project definitely involved the use of information technology, not only through the use of the device but also in the downloading and reporting of the information to the clinical staff. Work was done not only with the code blue quality team members but also members of the Wexner Medical Center information technology department. In addition, contact and collaboration with staff from Physio-Control was made to generate a sample report from CODE-STAT 9™ that could be used in the future with staff. This report was done to see the full

capability of both Code Stat™ and TrueCPR™. Information was also provided to the manufacturer of staff opinion on the device, especially with the issue of “slipping”. This project is only a small portion of emergency response in the inpatient setting, as mentioned above this can be tied to early response actions and working closely with that process can only strengthen the potential of improved patient outcomes. There is much focus on quality outcomes in the health care arena and code response is one with implications for improvement as teams begin to work together using evidence to provide state of the art care during the resuscitation process.

Recommendations

Information on progress of the trial and information on metrics was provided to the ICU staff during the last month of the trial. Recommendations to pursue after final review of the information would be to present the findings to staff in staff meetings to ascertain further feedback of not only the device but of the code process. As data was analyzed gaps were noted in compression depth as well as length of pauses and rhythm recognition. Often a team member is cognizant of performance deficits but does not speak up so it will be essential to continue to provide support in verbalizing standards during codes and providing pertinent information that may be missed by others on the team. Continued education, a process of continuous feedback, and mock codes may assist in improvement of the process without the purchase of a feedback device. Since the device did not appear to be used as a method of debriefing providing the metrics from CODESTAT 9™ within a week of the code may assist in recognition of potential deficits and encourage team improvement. These reports may be able to be placed in a secure area where staff can review and discuss. Additionally, continuing to encourage post code debriefing is an important aspect in improving code outcomes.

In regards to TrueCPR™, recommendations would be to continue to project and engage staff as there is pertinent information available on the device during the code that can be used to improve code metrics. However, if it came down to purchasing at this time analysis with the code blue committee and unit manager would be needed. Concerns are this is a first generation device; Physio-Control states their technology on compression depth is improved from other vendor models but staff voiced concerns about the movement of the device during compressions. This movement may hinder compression rather than promote effective compressions. From a cost perspective, this device is not unreasonably priced and since there are not a large number of cardiac events purchases of devices for certain areas may be fiscally possible. Switching to another vendor with a similar product would mean that all new defibrillators would need to be purchased which would be very costly to the University and most likely not cost effective. Waiting until the next generation of the device or improvements were made, working with the staff on improved communication, use of ETCO₂, and quicker feedback with CODESTAT 9™ may be the fiscally responsible process to deploy at this time.

References

- ANZICS-CORE MET dose Investigators. (2012). Rapid response team composition, resourcing and callin criteria in Australia. *Resuscitation*, 83, 563-567.
<http://dx.doi.org/10.1016/j.resuscitation.2011.10.023>Elsevier Scienc
- Banville, I., Rose, L., O'Hearn, P., Campbell, T., Nova, R., & Chapman, F. (2011). Abstract 217: Quality of CPR performed on a mattress can be improved with a novel CPR feedback device. Retrieved from http://circ.ahajournals.org.proxy.lib.ohio-state.edu/content/vol124/21_MeetingAbstracts
- Bobrow, B. J., Meaney, P. A., & Berg, R. A. (2014). Key recommendations from the AHA CPR quality consensus statement. Retrieved from <http://www.jems.com/article/administration-and-leadership/key-recommendations-aha-cpr-quality-cons#comments>
- Bohn, A., Weber, T. P., Wecker, S., Harding, U., Osada, N., VanAken, H., & Lukas, R. P. (2011). The addition of voice prompts to audiovisual feedback and debriefing does not modify CPR quality or outcomes in out of hospital cardiac arrest - A prospective randomized trial. *Resuscitation*, 82, 257-262. <http://dx.doi.org/>Retrieved from
- Campbell, J. P., Maxey, V. A., & Watson, W. A. (1995, November). Hawthorne effect: Implications for prehospital research. *Annals of Emergency Medicine*, 26, 590-594.
Retrieved from
- Carey, B. (2016). Continuous improvement should apply to DMAIC itself . Retrieved from <http://www.isixsigma.com/new-to-six-sigma/dmaic/continuous-improvement-dmaic/>
- Cheng, A., Brown, L. L., Duff, J. P., Davidson, J., Overly, F., Tofil, N. M., ... Nadkarni, V. M. (2015, February). Improving cardiopulmonary resuscitation with a CPR feedback device

- and refresher simulations (A CPR CARES project) A randomized clinical trial. *JAMA Pediatrics*, 169, 137-144. <http://dx.doi.org/10.1001/jamapdiatrics.2014.2616>
- Couper, K., Kimani, P. K., Abella, B. S., Chilwan, M., Cooke, M. W., Davies, R. P., ... Perkins, G. (2015, November). The system-wide effect of real-time audiovisual feedback and postevent debriefing for in-hospital cardiac arrest: the cardiopulmonary resuscitation quality improvement initiative. *Critical Care Medicine*, 43, 2321-2331. <http://dx.doi.org/10.1097/CCM.0000000000001202>
- Dorney, P. (2011, September/October). Chaos or control, an educational experience. *Journal for Nurses in Staff Development*, 27, 242-244. <http://dx.doi.org/10.1097/NND.0b013e31822d6ee4>
- Fernandez, R., Pearce, M., Grande, J. A., Rench, T. A., Jones, K. A., Chao, G. T., & Kozlowski, S. W. (2013, November). Evaluation of a computer-based educational intervention to improve medical teamwork and performance during simulated patient resuscitations. *Critical Care Medicine*, 41, 2551-2561. <http://dx.doi.org/10.1097/CCM.0b013e31829828f7>
- Fineout-Overholt, E., Melnyk, B. M., Stillwell, S. B., & Williamson, K. M. (2010, July). Evidence-based practice step by step critical appraisal of the literature: Part 1. *AJN*, 110, 47-52. <http://dx.doi.org/10.1097/01.NAJ.0000383935.22721.9c>
- Ginter, P. M., Duncan, W. J., & Swayne, L. E. (2013). *Strategic management of health care organizations* (7th ed.). [Kindle]. Retrieved from
- GRADE Working Group. (n.d.). <http://www.gradeworkinggroup.org/index.htm>
- Hazinski, M. F., Nadkarni, V. M., Hickey, R. W., O'Connor, R., Becker, L. B., & Zaritsky, A. (2005, November 28). Major changes in the 2005 AHA Guidelines for CPR and ECC:

Reaching the tipping point for change. *Circulation*, 112, IV-206-IV-211.

<http://dx.doi.org/10.1161/CIRCULATIONAHA.105.170809>

Hostler, D., Everson-Stewart, S., Rea, T. D., Stiell, I. G., Callaway, C. W., Kudenchuk, P. J., ...

Nichol, G. (2011). Effect of real-time feedback during cardiopulmonary resuscitation outside hospital: prospective, cluster-randomised trial. *BMJ*, 1-10. <http://dx.doi.org/>

Hsieh, T., Wolfe, H., Sutton, R., Myers, S., Nadkarni, V., & Donoghue, A. (2015). A comparison of video review and feedback device measurement of chest compressions quality during pediatric cardiopulmonary resuscitation. *Resuscitation*, 93, 35-39.

<http://dx.doi.org/10.1016/j.resuscitation.2015.05.022>

Hunziker, S., Tschan, F., Semmer, N. K., & Marsch, S. (2013, April 18). Importance of

leadership in cardiac arrest situations: from simulation to real life and back. *Swiss Medical Weekly*, 143, w13774. <http://dx.doi.org/10.4414/smw.2013.13774>

Kirkbright, S., Finn, J., Tohira, H., Bremner, A., Jacobs, I., & Celenza, A. (2014). Audiovisual feedback device use by healthcare professionals during CPR: A systematic review and meta-analysis of randomised and non-randomised trials. *Resuscitation*, 85, 460-471.

<http://dx.doi.org/10.1016/j.resuscitation.2013.12.012>

Kleinman, M. E., Brennan, E. E., Goldberger, Z. D., Swor, R. A., Terry, M., Bowbrow, B. J., ...

Rhea, T. (2015, November 3). Part 5: Adult basic life support and cardiopulmonary resuscitation quality: 2015 American Heart Association Guidelines Update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*, 132[suppl 2], S414-S435. <http://dx.doi.org/10.1161/CIR.0000000000000259>

- Kohn, L. T., Corrigan, J. M., & Donaldson, M. S. (Eds.). (2000). *To err is human: Building a safer health system*. [National Academies Press]. Retrieved from <http://www.nap.edu/catalog/9728.html>
- Kronick, S. L., Kurz, M. C., Lin, S., Edelson, D. P., Berg, R. A., Bill, J. E., ... Welsford, M. (2015,). November 3 [Supplemental]. *Circulation*, 132, S397-S413. <http://dx.doi.org/10.1161/CIR.0000000000000258>
- Kurowski, A., Szarpak, L., Bogdanski, L., Zasko, P., & Czyzewski, L. (2015). Comparison of the effectiveness of cardiopulmonary resuscitation with standard manual chest compressions and the use of TrueCPR and PocketCPR feedback devices. *Kardiol Pol*, 73, 924-930. <http://dx.doi.org/10.5603/KP.a2015.0084>
- Link, M. S., Berkow, L. C., Kudenchuk, P. J., Halperin, H. R., Hess, E. P., Moitra, V. K., ... Donnino, M. W. (2015, November 3). Part 7: Adult advanced cardiovascular life support: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*, 132, S444-S464. <http://dx.doi.org/10.1161/CIR.0000000000000261>
- Martin, P., Theobald, P., Kemp, A., Maguire, S., Maconochie, I., & Jones, M. (2013). Real-time feedback can improve infant manikin cardiopulmonary resuscitation by up to 79% - A randomised controlled trial. *Resuscitation*, 84, 1125-1130. <http://dx.doi.org/10.1016/j.resuscitation.2013.03.029>
- McCambridge, J., Witton, J., & Elbourne, D. R. (2014). Systematic review of the Hawthorne effect: New concepts are needed to project research participation effects. *Journal of Clinical Epidemiology*, 67, 267-277. <http://dx.doi.org/10.1016/j.jclinepi.2013.08.015>

Meaney, P. A., Bobrow, B. J., Mancini, M. E., Christenson, J., deCaen, A. R., Bhanji, F., ...

Leary, M. (2013, July 23). CPR quality: Improving cardiac resuscitation outcomes both inside and outside the hospital A consensus statement from the American Heart Association. *Circulation*, 128, 1-19. <http://dx.doi.org/10.1161/cir.0b013e31829d8654>

Moran, K., Burson, R., & Conrad, D. (2014). *The doctor of nursing practice scholarly project a framework for success*. Burlington, MA: Jones & Bartlett Learning.

Morrison, L. J., Gent, L. M., Lang, E., Nunnally, M. E., Parker, M. J., Callaway, C. W., ...

Hazinski, M. (2015, November 3). Part 2: Evidence evaluation and management of conflicts of interest 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*, 132[suppl 2], S368-S382. <http://dx.doi.org/10.1161/CIR.0000000000000253>

Neumar, R. W., Shuster, M., Callaway, C. W., Gent, L. M., Atkins, D. L., Bhanji, F., ...

Hazinski, M. F. (2015, November 3). Part 1: Executive summary: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care []. *Circulation*, 132, S315-S367. <http://dx.doi.org/10.1161/CIR.0000000000000252>

Pozner, C. N., Almozlino, A., Elmer, J., Poole, S., McNamamara, D., & Barash, D. (2011).

Cardiopulmonary resuscitation feedback improves the quality of chest compression provided by hospital health care professionals. *American Journal of Emergency Medicine*, 29, 618-625. <http://dx.doi.org/10.1016/j.ajem.2010.01.008>

Ramberg, E., Wolsk, E., Elkjaer, J. M., & Bulow, H. H. (2014). In-hospital cardiac arrest:

characteristics and outcome after implementation of systematic practice-oriented training.

American Journal of Emergency Medicine, 32, 765-767.

<http://dx.doi.org/10.1016/j.ajem.2014.04.009>

Rosswurm, M., & Larrabee, J. H. (1999). A model for change to evidence-based practice. *Image:*

Journal of Nursing Scholarship, 31, 317-322. <http://dx.doi.org/10.1111/j.1547->

5069.1999.tb00511.x

The case for CPR feedback devices. (2013). Retrieved from

<http://www.jems.com.proxy.lib.ohio-state.edu/article/patient-care/case-cpr-feedback-devices>

Truszewski, Z., Szarpak, L., Kurowski, A., Evrin, T., Zasko, P., Bogdanski, L., & Czyzewski, L.

(2015). Randomized trial of the chest compressions effectiveness comparing 3 feedback cardiopulmonary resuscitation devices and standard basic life support by nurses.

American Journal of Emergency Medicine. <http://dx.doi.org/10.1016/j.ajem.2015.11.003>

Wutzler, A., Bannehr, M., Von Ulmenstein, S., Loehr, L., Forster, J., Kuhnle, Y., ... Haverkamp,

W. (2015). Performance of chest compressions with the use of a new audi-visual feedback device: A randomized manikin project in healthcare professionals.

Resuscitation, 87, 81-85. <http://dx.doi.org/10.1016/j.resuscitation.2014.10.004>

Yeung, J., Davies, R., Go, F., & Perkins, G. D. (2014). A randomised control trial of prompt and feedback devices and their impact on quality of chest compressions - a simulation project.

Resuscitation, 85, 553-559. <http://dx.doi.org/10.1016/j.resuscitation.2014.01.015>

Yeung, J., Meeks, R., Edelson, D., Gao, F., Soar, J., & Perkins, G. D. (2009). The use of CPR feedback/prompt devices during training and CPR performance: A systematic review.

Resuscitation, 80, 743-751. <http://dx.doi.org/10.1016/j.resuscitation.2009.04.012>

Zapletal, B., Greif, R., Stumpf, D., Nierscher, F. J., Frantal, S., Haugk, M., ... Fischer, H. (2014).

Comparing three CPR feedback devices and standard BLS in a single rescuer scenario: A randomised simulation project. *Resuscitation*, 85, 560-566.

<http://dx.doi.org/10.1016/j.resuscitation.2013.10.028>

Appendices

Appendix A. Review of the literature

Article	Sample/Setting	Intervention	CPR providers	Significant Results	Limitations/Gaps	Level of Evidence
Kirkbright, et al., 2014 Audiovisual feedback device use by health care professional during CPR: A systematic review and meta-analysis of randomised and non-randomised trials	Reviewed human and manikin studies	Use of audiovisual feedback device during cardiopulmonary resuscitation (comparison of multiple devices - QCPR, CPREzy, VAM, experimental pressure monitor, Zoll pocket CPR, Zoll AED plus, Phillips modified Heartstart)	Health care practitioners	Improved chest compression parameters, did not translate to improved patient outcomes	Difficulty comparing heterogeneous projects with varying statistical significance, studies reviewed used different feedback devices	Level I: Systematic review and meta analysis
Yeung, et al., 2009 The use of CPR feedback/prompt devices during training and CPR performance: A systematic review	Review of literature for use of feedback device compared to no device	Use of audiovisual feedback device during cardiopulmonary resuscitation (comparison of multiple devices - skillmeter, VAM, QCPR, CPREzy, Cell phone, CPR plus, Metrinome, CAREvent, Heartstart AED)	Health care practitioners and lay persons	Good evidence supporting use of devices, more studies needed to see if patient outcomes are improved. Need to make sure that device does not distract or delay rescuer from performing CPR	Question if improved CPR will translate into improved patient outcomes. Need device that can be calibrated to take into account the stiffness of the support surface compressions are performed on	Level I: Systematic review
Wutzler, et al., 2015 Performance of chest compression with the use of a new audio-visual feedback device: a randomized manikin study in health care professionals	Study performed on manikin - Prospective randomized trial, measured CC quality (rate, depth)	Evaluation of TrueCPR - use of triaxial field induction (TFI) - compared to accelerator technology of other devices (ability to take into account the surface the patient is on - or movement of the patient)	Health care practitioners (physicians and nurses)	Found that feedback device significantly improves CC quality - rate and depth as well as time of compressions is decreased	Trial performed on manikin low stress environment - minimal distractions, participants volunteered so chance of selection bias, can not be generalized to lay persons	Level II: Randomized Control Trial
Yeung, et al., 2014 A randomised control trial of prompt and feedback devices and their impact on quality of chest compressions	Compare the effect of three CPR prompt and feedback devices on quality of CC on manikin by healthcare providers	Comparison of CPREzy, Phillips Q-CPR, metrinome on quality of CC	Healthcare providers	CPR feedback devices vary in their ability to improve performance. Pressure sensor - improved depth, accelerometer - reduced depth and metrinome had no effect - an ideal device does not exist	Trial performed on manikin - only reviewed 3 devices, minimal time to practice and familiarize self with the device	Level II: Randomized Control Trial

Article	Sample/Setting	Intervention	CPR providers	Significant Results	Limitations/Gaps	Level of Evidence
Pozner, et al., 2011 Cardiopulmonary resuscitation feedback improves the quality of chest compression provided by hospital health care professionals	Comparison of quality of CC, fatigue, and ease of use of device were compared with handheld device vs. no device by experienced hospital nurses	Comparison of quality of CC, fatigue, and ease of use of device were compared with handheld device vs. no device. Pocket CPR was device used. Performed compressions for 6 minutes	Experienced noncritical care hospital nurses - academic medical center	Study did show improvement in CC quality with use of device. Decrease in compression for both groups between the 1st and 2nd min of compressions. No perceived difference in fatigue between the 2 groups	Small clinical trial. Limited time compressions performed over, looking at fatigue of providers	Level II: Nonblinded randomized control trial
Cheng, et al., 2015 Improving cardiopulmonary resuscitation with a CPR feedback device and refresher simulations (CPR CARES study) A randomized clinical trial	Determine if just in time training (JIT) with visual feedback (VisF) before CPA or real-time VisF during CPA improves CC - manikin training	Use of CPRcard (Laerdal) during CC. JIT training included 5 min video and 2 min practice with device (each team member) vs. control - able to practice CPR for 2 min (each team member) - all simulations were standardized for each group. Mattress was removed from cart to eliminate mattress compressibility	Medical students, residents, physicians, nurses and NP's from 10 tertiary care centers - teams of 3 created for each CPA event, with one assigned team leader. Participants were excluded if they had prior knowledge of feedback devices	Showed that JIT CPR training before CPA or real-time VisF during CPR, alone or in combination, improves compliance with AHA guidelines	One simulated scenario over the study period - difficult to assess if generalizable to patient care. There was 45 min between JIT and CPA event, this is unpredictable in clinical setting	Level II: Randomized Control Trial
Couper, et al., 2015 The system-wide effect of real-time audiovisual feedback and postevent debriefing for in-hospital cardiac arrest: the cardiopulmonary resuscitation quality improvement initiative	Evaluation of cardiac arrest on adult in-patients, 18 years and greater. Examined survival and CPR quality	Two phase study, examined data at all hospitals prior to intervention. Intervention at 2 hospitals included turning on feedback device in defibrillator (QCPR), hospital 2 also received debrief in addition to feedback during code	Hospital personnel - all part of one health system, large teaching hospital	Intervention both device and debrief did not provide measurable improvement in patient or process outcomes. However, there was unexplained system-wide improvement in ROSC and CPR Quality	During study AHA guidelines changed with addition of quality, initiation of new defib tech and all staff were educated and were aware of ongoing study looking a CPR quality, contamination of study - staff on code team were required to go to all areas in both physicians and nursing had the greatest amount of time at all buildings	Level IV: Prospective cohort study

Article	Sample/Setting	Intervention	CPR providers	Significant Results	Limitations/Gaps	Level of Evidence
Martin, et al., 2013 Real-time feedback can improve infant manikin cardiopulmonary resuscitation by up to 79% - a randomized control trial	Infant evaluation (Laerdal 3month old, 5KG infant) of two thumb(TT) and two finger (TF) compressions on manikin. Examined compression quality based on 4 targets (CC depth, release force, CC rate, and duty cycle)	Investigation was embedded in formal EPLS/APLS training sessions. Data recorded before feedback and after feedback. Data obtained from Labview computer program .	EPLS and/or APLS certified CPR providers with previous certification <4 years. Group allocation was concealed from provider and investigator prior to experimental phase. Once phase began blinding was not possible	All providers were experience providers so baseline data shows best care scenario vs. non-expert. Expertise of providers may have hindered their performance, perceiving experimental set up as contrived, but it was embedded in certification training	Baseline data showed <1% of compression were performed to meet quality measures. Use of feedback showed statistical improvement (p<0.001) on all 4 measures, potentially improving clinical outcomes.	Level II: Randomized Control Trial
Hsieh, et al., 2015 A comparison of video review and feedback device measurement of chest compressions quality during pediatric cardiopulmonary resuscitation	Review of video recordings of pediatric resuscitations in ED for ongoing OHS cardiac arrest or for cardiac arrest or bradycardia in ED - IHSCA. Patients >8 years old	Q-CPR was the device used to collect data. If Q-CPR was not used data was not collected from the video recordings - a comparison was then made from Q-CPR to human observation from the video	Health care providers in the emergency department	Use of videorecordings is accurate for determining compression rate but poor for compression depth and chest wall leaning	Small study in single tertiary pediatric hospital, difficult to generalize.	Level IV: Observational Study
Banville, et al., 2011, Quality of CPR performed on a mattress can be improved with a novel CPR feedback device	Comparison of two feedback devices using different technology to measure chest compression depth on manikin	Comparison of TrueCPR to Q-CPR on chest compressions when performed on hospital mattress - TrueCPR uses Triaxial field induction and Q-CPR uses accelerometer. Compression quality was measured using Resusci Ann SkillReporter	22 Critical care nurses - randomized to device type and performed 2 minutes of continuous compressions with and without feedback	Accelerometer feedback reported depth significantly higher than actual depth, difference is mattress deflection under compression. TFI guided rescuers to correct target zone. TFI was modified after this trial to increased metrinome tick rate	Small single study, appears to have been sponsored by Physiocontrol	Level III: Well controlled trial without randomization
Hostler, et al., 2011, Effect of real-time feedback during cardiopulmonary resuscitation outside hospital: prospective, cluster-randomised trial	Utilization of feedback device in a randomized trial in out of hospital cardiac arrests	Emergency medical providers were trained to use the Q-CPR device. During randomization the device was to be turned on for feedback or left in data collection mode only (no intervention). Large randomized study - 771 without feedback, 815 with feedback, 3 different cities	Emergency medical providers	Real time feedback did altered performance to more closely conform with the guidelines - but this did not improve ROSC or other clinical outcomes. Changes have assisted with limiting delays in care	Bias - all providers did receive training on the device - feedback off arm already had good outcomes - little opportunity for improvement. Feedback was corrective, not prescriptive may have taken away from other elements of CPR	Level II: Well designed RCT

Article	Sample/Setting	Intervention	CPR providers	Significant Results	Limitations/Gaps	Level of Evidence
Bohn, et al., 2010, The addition of voice prompts to audiovisual feedback and debriefing does not modify CPR quality or outcomes in out of hospital cardiac arrest - a prospective randomized trial	Utilization of feedback device with voice prompts to a metronome and visual feedback. Variables measured included compression rate, depth, and CCF	Randomized 2 arm pre-hospital study using Zoll AED pro with CPR-D . Training was 90 min lecture on importance of following guidelines followed by 90 min of simulated resuscitation scenarios.	Emergency medical providers	Addition of voice prompts does not neither modify or CPR quality or outcome. Further studies needed to determine best configuration of feedback to improve CPR quality and survival	Personnel using device may have been in both groups due to rotation of services, intensive training prior to use of device may have affected results	Level III: Well controlled trial without randomization
Truszewski, et al., 2015, Randomized trial of the chest compressions effectiveness comparing 3 feedback CPR devices and stand BLS by nurses	Compared 3 feedback devices and traditional BLS to each to determine effectiveness of each method-Randomized into order of devices, were not able to watch other participants, had 20 minute rest between each trial performed single rescuer CPR for 8 minutes	All received 30 minute training on pathophys of cardiac arrest and techniques of CC using TrueCPR, CPR-Ezy, and iCPR and then were able to practice using devices on manikin	160 nurses - no experience with feedback devices - emergency room nurses and emergency medical service teams	Only TrueCPR significantly affected the increased effectiveness of compression compared with standard BLS, CPR-Ezy, and iCPR.	Study carried out on manikin. Limited type and number of participants	Level II: Randomized Control Trial
Kurowski, et al., 2015, Comparison of the effectiveness of cardiopulmonary resuscitation with standard manual compressions and the use of TrueCPR and PocketCPR feedback devices	Effectiveness of chest compressions were evaluated using standard CPR, and two feedback devices, each was performed for 10 min. Order of performance was randomized. Allowed 20 minute rest period between	Participants received 30 min training on adult CPR which included use of feedback devices. After training were allowed to practice for 2 min. Devices used were TrueCPR and PocketCPR	167 paramedics, no previous experience with TrueCPR and PocketCPR feedback devices. During experience only guided by their knowledge and info from device if used	Chest compression depth was higher with use of TrueCPR, Pocket CPR was better than SMCC. Compression rate was at 105 with TrueCPR, Pocket CPR 89, and SMCC 118. Found highest chest compression effectiveness with TrueCPR	Study carried out on manikin. Limited type and number of participants	Level II: Randomized Control Trial
Zapletal, et al., 2014, Comparing three CPR feedback devices and standard BLS in a single rescuer scenario: A randomised simulation study	Prospective randomised trial compared 3 feedback devices with standard BLS on CPR quality. All received similar initial training at time of randomization were allowed to practice with device or receive feedback on standard CPR until comfortable. Then were to perform 8 minutes of one person CPR	Participants received standard BLS training prior to the intervention - all were familiarized with the 3 feedback devices (PocketCPR, CPRmeter, and iPhone app - Pocket CPR). Compressions were performed on manikins on floor (takes out mattress variability)	240 trained medical students -	Found differences between the devices but compressions were suboptimal in all groups - all feedback devices created delay in CPR which may worsen outcomes	Study carried out on manikin. Limited type of participants	Level II: Randomized Control Trial

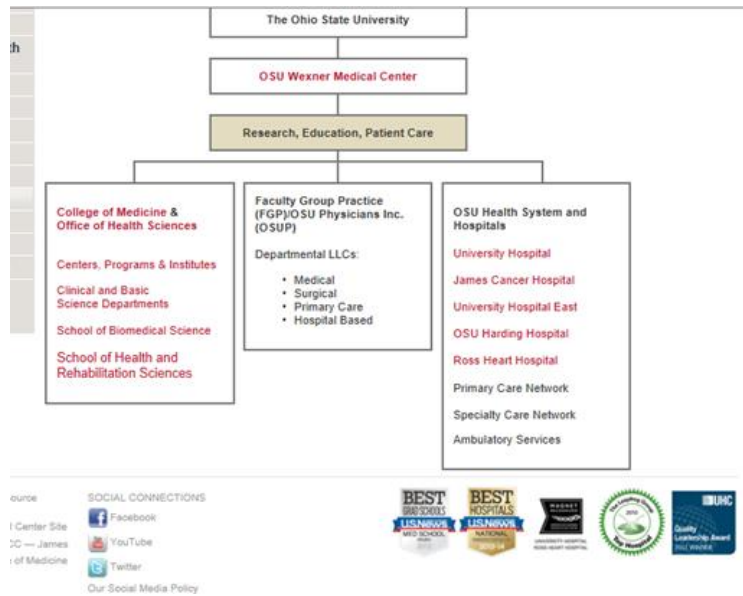
Article	Sample/Setting	Intervention	CPR providers	Significant Results	Limitations/Gaps	Level of Evidence
Kronick, et al., 2015, Part 4: Systems of care and continuous quality improvement: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care	Summary of both in-hospital and out of hospital cardiac arrest best practices with focus on development of quality program			Each system needs to define its own goals. Can use problem solving model of choice to achieve continuous quality improvement - "improvements are made after direct observation and analysis of root causes, with changes piloted as experiments, ideally by the workers who propose them"		Level VII: Expert Opinion
Kleinman, et al., 2015, Part 5: Adult basic life support and cardiopulmonary resuscitation quality: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care	Summary of both in-hospital cardiac arrest response recommendations			Class II a recommendation - compression rate 100-120; Class I recommendation - Compress at least 2 inches; Class II b recommendation - CCF at least 60%; Class II b recommendation - may be reasonable to use audiovisual feedback device during CPR for real-time optimization of CPR performance		Level VII: Expert Opinion

Appendix B. Synthesis of Literature

Article	Manikin	Human	In Hospital	Out of Hospital	Health Care Providers	Laypersons	Audiovisual feedback	TrueCPR	Adults	Pediatrics	Improved Chest Compressions	Improved Compression Quality
1	x	x			x		x				x	
2					x	x	x				x	
3	x				x			x	x		x	
4	x				x		x		x			
5	x				x		x		x			x
6	x				x		x		x		x	
7		x	x		x				x			
8	x				x		x			x	x	
9		x	x	x	x		x			x	x	
10	x				x		x	x			x	
11		x		x	x		x		x		x	
12		x		x	x		x		x		x	
13	x				x		x	x			x	
14	x				x		x	x	x			
15	x				x		x		x			

1. Kirkbright, et al., 2014. 2. Yeung, et al., 2009 3. Wutzler, et al., 2015 4. Yeung, et al., 2014 5. Pozner, et al., 2011 6. Cheng, et al., 2015 7. Couper, et al., 2015 8. Martin, et al., 2013 9. Hsieh, et al., 2015 10. Banville, et al., 2011 11. Hostler, et al., 2011 12. Bohn, et al., 2010 13. Truszewski, et al., 2015 14. Kurowski, et al., 2015 15. Zapletal, et al., 2014

Appendix C. Who's Who at OSU



Appendix D. University Mission, Vision, and Values

ONE GREAT MEDICAL CENTER

As one of the most comprehensive health sciences campuses in the country, with nearly 7 million square feet of research, education and patient care facilities operated by more than 16,000 dedicated faculty, staff and students, The Ohio State University Medical Center plays a pivotal role in helping the University achieve eminence. This shared objective is visible in the mission and vision of the Medical Center, and the core values we share as part of the University.

Our Mission:
To improve people's lives through innovation in research, education and patient care.

Our Vision:
Working as a team, we will shape the future of medicine by creating, disseminating and applying new knowledge, and by personalizing health care to meet the needs of each individual.

Our Values:

- Excellence
- Collaborating as ONE University
- Acting with Integrity and Personal Accountability
- Openness and Trust
- Diversity in People and Ideas
- Change and Innovation
- Simplicity in Our Work
- Empathy and Compassion
- Leadership

Our Promise:
Creating the future of medicine to improve people's lives through personalized health care.

Appendix E. Key Result Areas

Medical Center Strategic Goals:

- Become a top-20 academic medical center and a top-10 National Cancer Institute-funded cancer program through advancement in research, education and patient care.
- Generate an investment fund for mission development.
- Create a high-performance organization and workplace of choice.

Key Result Areas:

Medical Center leaders have identified six Key Result Areas (KRAs) to promote alignment with the Medical Center's strategic goals and help us become a high-performance organization. The KRAs are used to set standards for performance excellence, and every area within the Medical Center maintains a scorecard to help measure institutionwide progress. The KRAs are also used to measure accountability and performance in each employee's Personalized Performance Plan (P3).

Innovation and Strategic Growth:

Promote innovative clinical, educational and research programs and grow the enterprise to meet our strategic goals.

Service and Reputation:

Provide the ideal patient and student experience and seek national distinction in research, education and patient care.

Quality:

Promote quality and safety in clinical care and excellence in education and research.

Productivity and Efficiency:

Steward our resources effectively and enhance productivity in clinical care, research and education.

Financial Performance:

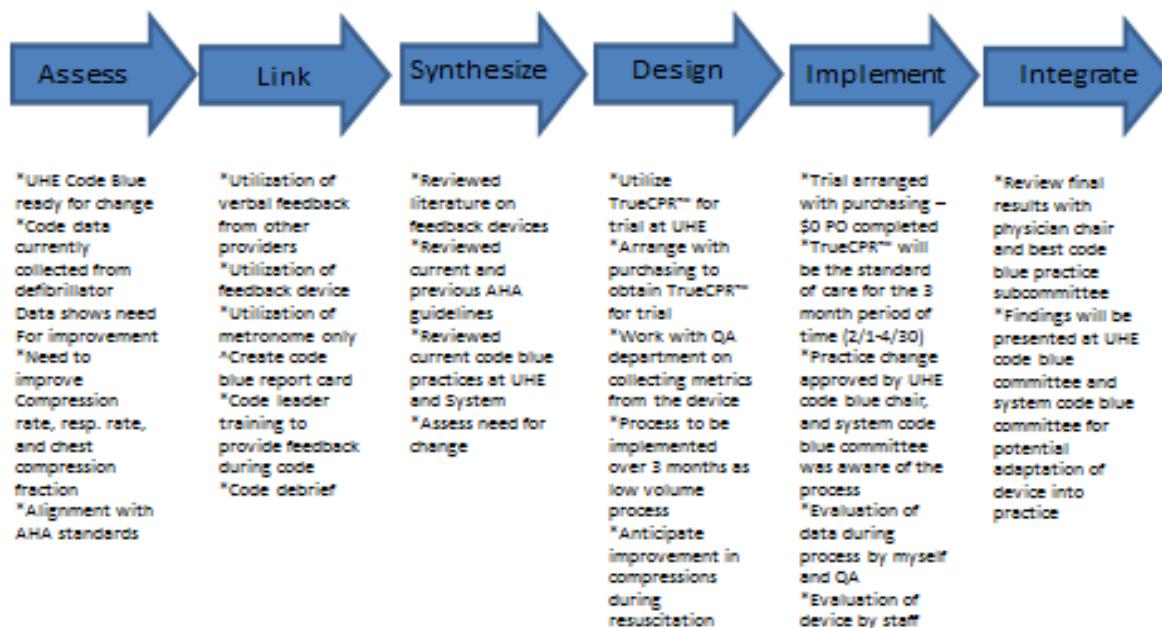
Promote sustainable increases in revenue and philanthropic support and the prudent distribution and use of all financial resources in order to reinvest in our mission.

Workplace of Choice:


Create an environment that promotes student, faculty and staff satisfaction and engagement.

Appendix F. Theoretical Model

Utilization of a Feedback Device During Cardiopulmonary Resuscitation



Appendix G. Purchasing Evaluation of TrueCPR™

Key Points Requested By: Sheila Chucta Vendor: Physiocontrol Product Name: TrueCPR	Current State Currently we use Code Stat to download code information. This is not real time, generally available quarterly. Bedside staff has minimum visibility to this data unless management shares. With The True CPR, data is immediately available. Currently we pay \$2000 for Code Stat software updates and a Maintenance Subscription of \$1500.
Product Description The Physio-Control TrueCPR coaching device provides rescuers with real-time feedback on chest compressions during cardiopulmonary resuscitation (CPR) in accordance with current CPR guidelines. The TrueCPR™ Coaching Device is designed to optimize the quality and performance of manual CPR by providing feedback to rescuers in both real time and after the event. The TrueCPR device measures compression depth on compliant surfaces and in moving vehicles using a unique technology called Triaxial Field Induction Before using the TrueCPR device on a patient, the operator should be trained in the proper technique for performing CPR with the TrueCPR device. It is recommended that CPR performance metrics be included in your TrueCPR device training program. 	Clinical Considerations Utilization of this device during a cardiac resuscitation event should assist in providing the standard of resuscitation per AHA guidelines, compression rate of 100-120/minute and respiratory rate of 10-12/minute. Additionally, this will strengthen the code quality
Financial Impact (annualized) Cost for TrueCPR is \$1651.40, based on code data, feel 3 would be enough Require battery replacement: 2 DL 123 per device box of 6 can be purchased using PS # 5046206 at \$17.40 per box batteries checked during crash cart inspection	Physician Comments/Trial Results

Appendix H. Education of TrueCPR™



TrueCPR™



- Intended use – assist with CPR performance
 - Used on patients 8 years of age and older during cardiac arrest
- Device
 - Consists of chest pad placed on the sternum and back pad placed beneath the patient
 - Provides feedback on rate and depth of compressions during resuscitation
 - Provides a metronome to be used during compressions
 - Assists with providing correct rate and depth of compressions and ventilation rate

Why???

- Quality compressions have been shown to improve outcomes
- AHA Recommendations
 - Compressions 100-120
 - Ventilation Rate 10-12/minute
 - During CPR interruptions should be minimized – Performed 90% of time during the event
- UHE Data
 - CPR total compressions – 83%
 - Ventilation rate 10-12 – 33%
 - Compressions 100-120 – 17% of the time

How to Use

- Remove device from carrying bag
 - Devices will be on each crash cart in ICU and Pyxis by code drugs to take to off unit codes
- Separate the chest pad and back pad
- Press the power button and turn the device on – do not press chest pad until calibration is complete
- Position the back pad beneath the patient
- Place chest pad on dry chest.
 - Palm pad is in the middle of the chest, on the lower half of the sternum
- Place the heel of your hand on the palm pad and begin compressions in the time of the metronome
- Observe screen for feedback and any alert functions
 - Adjust technique based off feedback
- Provide rescue breaths when prompted
 - Provide 2 breaths after 30 compressions
 - When intubated turn airway prompt off, provides breaths every 6-8 seconds
- Turn device off pressing power button
 - Will turn off after 10 minutes of inactivity

Appendix I. Sample of CODE-STAT 9™ feedback report

